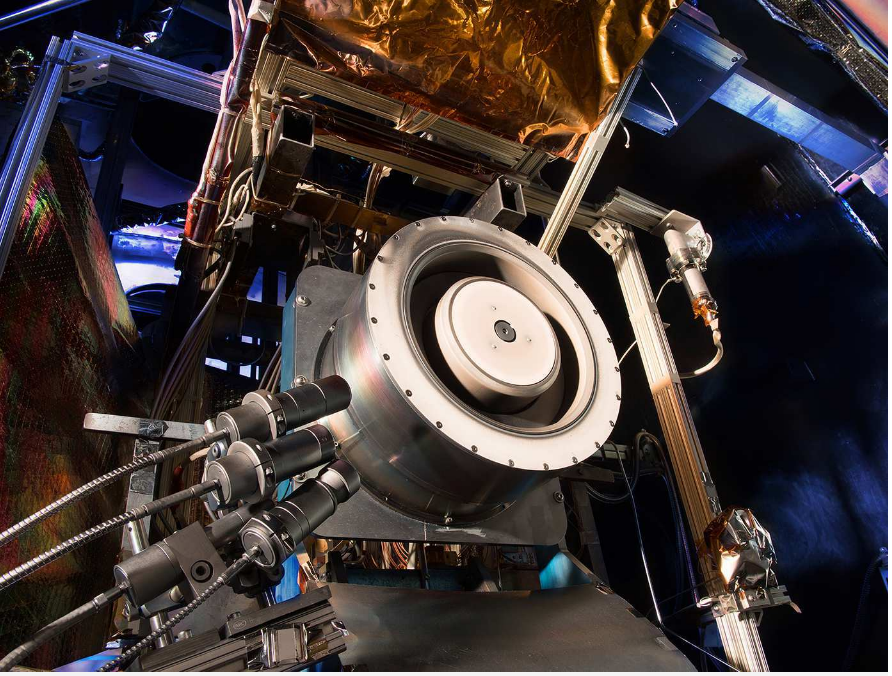


National Aeronautics and
Space Administration

technology solution

Propulsion

Hall Effect Thruster Technologies

New breakthroughs in durability and efficiency

Innovators at NASA's Glenn Research Center have developed several new technological innovations to improve the capability of Hall effect thrusters, which are used primarily on Earth-orbiting satellites and can also be used for deep-space robotic vehicles. Hall thrusters are susceptible to discharge-channel erosion from high-energy ion impingement, which can reduce operational thruster lifetimes. Glenn researchers have developed several approaches to mitigate this problem. One is a magnetic circuit design that minimizes discharge chamber ion impingement. Another successful improvement developed by Glenn is a means of replacing eroded discharge channel material via a channel wall replacement mechanism. A third innovation is a propellant distributor that provides both a high degree of flow uniformity and shielding from back-sputtered contamination and other potential contaminants. All of these advances work toward increasing the operational lifetime and efficiency of Hall thrusters.

BENEFITS

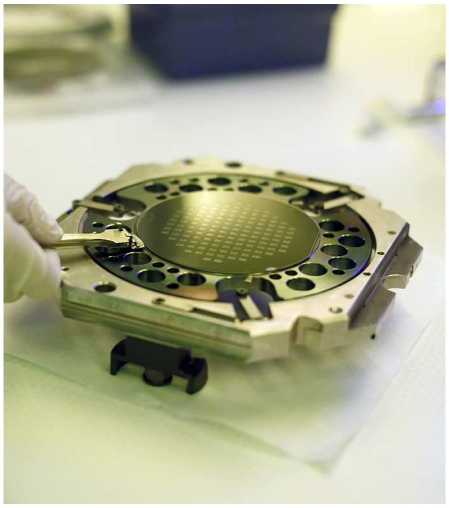
- Improved efficiency: Unique designs minimize energy loss to the discharge chamber, which improves discharge efficiency
- Increased lifetime: A reduction in the collisions of energetic ions and debris with the discharge chamber increases the chambers lifetime
- Enhanced reliability: The design's beam symmetry ensures the plasma produced will be symmetrical even if the mass of the magnetic circuit is minimized

THE TECHNOLOGY

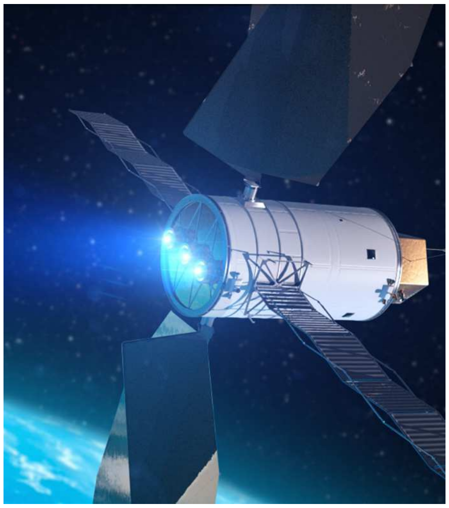
Glenn has developed three important advances in the operation of Hall effect thrusters. First, Glenn's novel design for the plasma accelerator addresses the problems created by radial magnetic fields at the dielectric discharge chamber wall. Conventional magnetic circuits may allow high-energy ions to cause erosion in the ceramic discharge chamber. This erosion can ultimately damage the surrounding magnetic system and shorten the operational lifespan of the thruster. NASA's novel design relies on an azimuthally symmetric configuration that minimizes radial magnetic fields at the discharge chamber walls, which shield the high-energy plasma ions from the walls of the discharge chamber. With this design, the lifetime of the Hall thruster can be extended well beyond 10,000 hours.

With regard to the discharge-channel-wall replacement innovation, an actuator can be configured to extend the discharge chamber along the centerline axis. The actuator can be either mechanical, set to extend the sleeve a particular distance for a particular duration, or programmable, set to monitor operating conditions and extend the sleeve when suitable. In either case, the sleeve can be extended while an upstream portion of the discharge chamber remains stationary, thereby preventing plasma exposure.

In the third enhancement, multiple outlets can be configured to distribute a flow of propellant to an ionization zone of a thruster discharge channel, often in conjunction with a plenum chamber, to equalize pressure for more even distribution of the propellant. All three Glenn innovations ensure that Hall thrusters will work with much greater efficiency and last considerably longer.



Glenn's Hall effect thruster technology has direct implications for semiconductor manufacturing processes, such as ion etching (pictured above).



Glenn's new development will make propulsion systems (such as in this solar electric propulsion satellite) last longer and work more efficiently.

APPLICATIONS

The technology has several potential applications:

- Propulsion (e.g., space, military, commercial satellites)
- Material processing (e.g., ion implantation, ion etching)
- High-energy physics

PUBLICATIONS

Patent No: 7,500,350; 7,624,566

Patent Pending

More Information

National Aeronautics and Space Administration

Technology Transfer Office

Glenn Research Center

21000 Brookpark Road
Cleveland, OH 44135
216-433-3484
grc-techtransfer@mail.nasa.gov

http://technology.nasa.gov/

www.nasa.gov

NP-2015-04-1531-HQ

LEW-17664-1, LEW-17678-1, LEW-19121-1